

SECTION 02585

UNDERGROUND DUCTBANK SYSTEMS

LANL MASTER CONSTRUCTION SPECIFICATION

When editing to suit Project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the Engineering Standards Manual (ESM) Electrical POC. Refer to

http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc_techcom1.htm#elec for the Engineering Standards Manual Personnel Link Index.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

Specification developed for ML-3 / ML-4 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

PART 1 GENERAL

1.1 SECTION INCLUDES

Edit A through D to match Project requirements. Delete items not applicable to Project.

- A. Underground ductbanks for medium-voltage power.
- B. Underground ductbanks for telecommunications.
- C. Underground ductbanks for secure communications.
- D. Manholes for medium-voltage power.
- E. Manholes for telecommunications.
- F. Manholes for secure communications.

1.2 LANL PERFORMED WORK

- A. None

1.3 SUBMITTALS

- A. Submit the following in accordance with Section 01330 – *Submittal Procedures*:

Delete the following specification article if manholes are not needed.

1. Catalog Data: Submit catalog data describing pre-cast manhole(s), manhole frame(s) and lid(s), ladders, and cable racks. Include data substantiating that materials comply with specified requirements.
2. Test Reports: Submit report of duct blockage tests.

1.4 QUALITY ASSURANCE

- A. Comply with the *National Electrical Code (NEC)* and *IEEE C2 – National Electrical Safety Code (NESC)* for components and installation.
- B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.

1.5 RECEIVING, STORING AND PROTECTING

- A. Receive, store, and protect, and handle products according to *NECA 1 – Standard Practices for Good Workmanship in Electrical Construction*.

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Alternate products may be accepted; follow Section 01630 – *Product Options and Substitutions*.

2.2 INTERMEDIATE METAL CONDUIT AND FITTINGS

- A. Furnish intermediate metal conduit (IMC) that meets the requirements of UL1242 – *Intermediate Metal Conduit* and ANSI C80.6 – *Intermediate Metal Conduit*.
- B. For intermediate metal conduit, furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL514B – *Fittings for Conduit and Outlet Boxes*, and ANSI/NEMA FB1 – *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*.

2.3 RIGID GALVANIZED STEEL CONDUIT AND FITTINGS

- A. Furnish rigid galvanized steel conduit (RGS) that meets the requirements of UL6 – *Rigid Metal Electrical Conduit* and ANSI C80.1 – *Rigid Steel Conduit, Zinc Coated*.
- B. For rigid galvanized steel conduit, furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL514B and ANSI/NEMA FB1.

2.4 PLASTIC-COATED STEEL CONDUIT AND FITTINGS

- A. Furnish PVC exterior coated, urethane interior coated, galvanized rigid steel conduit or intermediate metal conduit that meets the requirements of NEMA RN 1 – *PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit*.

- B. Use factory-fabricated elbows.
- C. For plastic-coated steel conduit, furnish 40 mil PVC exterior coated, urethane interior coated, zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL514B – *Fittings for Conduit and Outlet Boxes* and NEMA RN 1 – *PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit*.

2.5 RIGID NON-METALLIC CONDUIT AND FITTINGS

- A. Furnish rigid non-metallic conduit (PVC) that meets the requirements of UL651 – *Schedule 40 and 80 Rigid PVC Conduit* and NEMA TC 2 – *Electrical Plastic Tubing and Conduit*, ANSI C80.3.
- B. For rigid non-metallic conduit, furnish non-metallic, solvent-welded socket fittings that meet the requirements of UL514C – *Non-Metallic Fittings for Conduit and Outlet Boxes*, and NEMA TC 3 – *PVC Fittings for Use with Rigid PVC Conduit and Tubing*.

2.6 UTILITIES DUCT AND FITTINGS

- A. Furnish PVC type EB, 90 degree C rated, utilities duct for concrete encasement that conforms to the requirements of NEMA TC 6 – *Plastic Utilities Duct for Underground Installation*, ANSI C130.2, ASTM F-512 – *Standard Specification for Smooth-Wall PVC Conduit and Fittings for Underground Installation*, and UL-651A.
- B. For utility duct, furnish PVC fittings that conform to NEMA TC 9 – *Fittings for Plastic Utilities Duct for Underground Installation* and ASTM F-512 – *Standard Specification for Smooth-Wall PVC Conduit and Fittings for Underground Installation*.

2.7 DUCT SPACERS

- A. Furnish duct spacers that provide 3 inch separations between ducts and minimum 3 inch concrete coverage on bottom sides and top.
- B. Manufacturers: Underground Devices "Wunpeece".

2.8 GROUND CABLE

- A. Provide 4/0 AWG bare stranded, soft temper copper cable that conforms to ASTM B 8, *Standard Specification for Concentric-Lay Stranded Copper Conductors*.

2.9 CORROSION PROTECTION TAPE

- A. Furnish pressure-sensitive, 10 mil thick. PVC based tape for corrosion protection of metal conduit and fittings.
- B. Manufacturer: 3M, Type 50.

2.10 CONCRETE

- A. Use concrete with maximum 1/2 inch coarse aggregate and Type 1 Portland cement (ASTM C 150 – *Standard Specification for Portland Cement*) that has a slump of 6 to 7 inches and acquires a compressive strength of 3000 psi in 28 days. See Section 03300 for concrete mix design requirements.
- B. Color concrete red for permanent marking of ductbanks containing medium voltage cables.
 - 1. Use 2.0 lb. of pigment per 94 lb. sack of cement.
 - 2. Manufacturer: Rockwood Industries/Davis Colors, No. 1117.

Edit the following specification article to match Project requirements.

2.11 UNDERGROUND WARNING TAPE

- A. Furnish underground warning tape for underground duct banks.
- B. Use 6 inch wide, 0.004 inch thick, polyethylene underground warning tape with the following background colors:
 - 1. Electric: Red
 - 2. Telephone/Data: Orange
- C. Lettering shall be black and indicate the type service buried below.
 - 1. Electric: "CAUTION ELECTRIC LINE BURIED BELOW"
 - 2. Telephone/Data: "CAUTION TELEPHONE LINE BURIED BELOW"
- D. Manufacturer: Electromark, Utility Safeguard, LLC.

2.12 RACEWAY MEASURING/PULLING TAPE

- A. Furnish raceway measuring/pulling tape with permanently printed measurements in one-foot increments and minimum 1200 lb average breaking strength.
- B. Manufacturer: Greenlee "39243"

Edit the following article to match Project requirements. Delete if not applicable to Project.

2.13 SMOKE AND FIRE STOP FITTINGS

- A. Furnish NRTL listed, 3 hour rated smoke and fire stop fittings designed for placement around rigid steel conduit, intermediate metal conduit or electrical metallic tubing passing through core-drilled or cast-in-place holes in concrete floors or walls.

- B. Manufacturer: O-Z/Gedney, Type CFS.

Edit the following article to match Project requirements. Delete if not applicable to Project.

2.14 INSULATING BUSHINGS

- A. Provide NRTL listed insulating bushings with 105 °C rated insulation.
- B. Manufacturer: O-Z/Gedney, Type IB.

Edit the following article to match Project requirements. Delete if not applicable to Project.

2.15 GROUNDING BUSHINGS

- A. Provide NRTL listed, galvanized malleable iron, 150°C rated insulated throat grounding bushings with lay-in type ground cable lugs.
- B. Manufacturer: O-Z/Gedney, Type BLG.

Edit the following article to match Project requirements. Delete if not applicable to Project.

2.16 DUCT PLUGS

- A. Provide rubber duct plugs that will produce a positive seal in unused ducts against water and gas. Plugs shall be made of soft, expansible rubber compressed with galvanized steel plates and bolts.
- B. Manufacturer: Condux, Jackmoon USA, Inc.

Edit the following article to match Project requirements. Delete if not applicable to Project.

2.17 DUCT SEALANT

- A. Provide smoke sealant and fire barrier latex caulk that has intumescent and endothermic properties and has UL Classified system ratings of up to four hours.
- B. Manufacturer: 3M, type CP 25WB+ Caulk.

Edit manhole size(s) to match Project requirements. Delete specification article if manholes are not needed.

2.18 PRE-CAST MANHOLES

- A. Provide pre-cast concrete manholes that conform to the requirements of ASTM C478 – *Standard Specification for Precast Reinforced Concrete Manhole Sections*.

1. Electrical manholes with the following minimum inside dimensions: 12'-0" long, 6'-0" wide, 7'-0" high or as shown on the drawings. Coordinate with the LANL Support Services Subcontractor electrical distribution engineer.
 2. Telecommunications manholes with the following minimum inside dimensions: 12'-0" long, 6'-0" wide, 7'-0" high or 8'0" long, 6'0" wide, 7'0" high. Coordinate requirements with LANL Telecommunications Group.
- B. Minimum thickness of floor, walls and roof shall be 6 inches.
- C. Minimum design loading shall be 300 lb. per sq. ft.; design loading shall be AASHTO HS-20 per AASHTO HB-17 where manhole is installed in a street or paved parking area.
- D. Manhole floor shall be cast integral with walls to form the bottom ring.
- E. Provide a keyed joint between the bottom ring and top ring.

Edit knockout sizes and locations to match Project requirements.

- F. Provide 30 in. X 30 in. knockout panels, one in each end wall and two in each side wall of manhole. Coordinate locations of knockout panels in telecommunications manholes with LANL Telecommunications Group.
- G. Provide a 12 inch diameter sump hole with cast iron cover in the floor.
- H. Provide a 36 inch diameter access opening centered in the roof of the manhole.
- I. Provide pre-cast concrete grade rings as required to place top of manhole flush with paving or 2 to 4 in. above finished grade. Grade rings shall have a minimum inside diameter of 36 inches. Provide cast iron manhole steps at 16 in. on-centers.
- J. Provide lifting inserts in each manhole section for unloading and positioning.
- K. Provide one hot dip galvanized steel pulling iron under each knockout panel, two along each side wall and one under the manhole access opening (total of seven). Pulling iron shall have a capacity of 8000 lb. with a safety factor of 2.
- L. Provide 1-5/8 in. X 1-5/8 in. hot dip galvanized steel continuous inserts embedded in each side wall of manhole.
1. Position inserts horizontally and space 20" apart with bottom insert 12 in. above the floor.
 2. Extend inserts to within 6 in. of end walls.
 3. Manufacturer: Unistrut, P3200 series.
- M. Manufacturers: ARCO Concrete, Inc; AMCOR Pre-cast; Pre-Cast Manufacturing, Co.; 4-Corners Pre-Cast; Vaughn Concrete Products, Inc.

Delete the following specification article if manholes are not needed.

2.19 PREMOLDED JOINT FILLER

- A. Provide a closed cell expanded neoprene joint filler conforming to ASTM D1056 – *Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber*.
- B. Manufacturer: Williams Products, Inc., Type NN-1

Delete the following specification article if manholes are not needed.

2.20 COLD APPLIED ASPHALT EMULSION DAMP-PROOFING

- A. Provide asphalt-water emulsion coating, compounded to penetrate precast concrete substrate and build to a moisture-resistant coating.
- B. Emulsion shall be non-fibrated, asbestos-free liquid conforming to ASTM D1227, Type III.
- C. Manufacturers: ChemRex, Inc. / Sonneborne Building Products Div., Karnak Chemical Corporation.

Delete the following specification article if manholes are not needed.

2.21 MANHOLE ACCESSORIES

- A. Provide heavy duty cast iron manhole frame with solid lid.
 - 1. Material shall conform to ASTM A48 – *Standard Specification for Gray Iron Castings, Class 35B*.
 - 2. Frame and lid shall be suitable for AASHTO HS-20 wheel loads.
 - 3. Minimum clear opening through the frame will be 30 inches.
 - 4. Provide lid lettering "ELECTRIC" for power manhole and "TELEPHONE" for communications manhole.
 - 5. Manufacturer: Neenah Foundry Company, Model R-1640-C1 (power), Model R-1750-C (telephone [open]) or model R-1751-C (telephone [secure, lockable]).
- B. Provide hooked manhole ladder that complies with OSHA 29 CFR 1910.27 and ANSI A14.36 – *Safety Code for Fixed Ladders*.
 - 1. Ladder shall be fabricated from steel conforming to ASTM A36 – *Standard Specification for Structural Steel*.

2. Paint manhole ladder as follows: One coat of rust inhibiting primer, 2 - 3 mil minimum wet thickness. Two finish coats of water based alkyd enamel, 3 mil minimum wet thickness, and safety yellow color.
 3. Manufacturer: Condux, Inwesco.
- C. Provide heavy duty non-metallic cable racks and arms for manholes.
1. Each member shall be molded in one piece from UL listed glass reinforced nylon that can be field cut to length.
 2. Provide 14 in. long arms and/or 3 in. saddle arms. Coordinate quantity and types with the LANL Support Services Subcontractor electrical distribution engineer and the LANL Telecommunications Group.
 3. Manufacturer: Underground Devices, Inc., #CR36 36 in. rack, #RA14 arm, and 3HDS arm (saddle arm).
- D. Use hot dip galvanized, electro-galvanized or stainless steel fasteners and hardware in manholes.

Delete the following specification article if manholes are not for secure communications.

- E. For each manhole with secure communications ducts provide a 30"x 48"x 10", lockable, wall mounted junction-box with non-removable hinges and no knockouts. All secure communications ducts will be terminated in this junction-box. Manufacturer: Hoffman #A-304810WFPL with welded hinge pins and L36 padlock handle.

PART 3 EXECUTION

3.1 PREPARATION

- A. Install underground ductbank systems according to the NEC, the NESC, NECA/NEMA 600 – *Standard Practices for installing Underground Nonmetallic Utility Duct*, and the requirements in this Section.
- B. Duct bank system routing shown on Drawings is in approximate locations unless dimensioned. Route as required to complete the system.
1. Coordinate underground ductbank system work to avoid interference with other trades and existing utilities.
 2. Verify routing and termination locations of duct banks before excavation for rough-in.
 3. Verify that field measurements are as shown on Drawings.

Delete the following specification article if ductbank systems are not for secure communications.

4. For secure communication ductbank systems notify the LANL Contract Administrator at least 30 days prior to the scheduled construction of the ductbank to have design drawings and an Enclosure 2 form, found at <http://int.lanl.gov/security/computer/protdistrib.shtml>, submitted to the CCN-4 PTS POC. Once approval has been obtained by the LANL Chief Information Office-PTS Group, the Contract Administrator or University Technical Representative will inform contractor that construction may begin.

Delete the following specification article if ductbank systems are not for secure communications.

5. For secure communication ductbank systems notify the LANL Contract Administrator at least 2 working days prior to the scheduled concrete encasement of the ductbank. The LANL Chief Information Office-PTS group must perform an inspection of the secure ductbank prior to encasing with concrete.
- C. A position trench so ductbanks will have the following minimum horizontal and vertical separations from parallel or perpendicular runs other utility pipes or conduits.

UTILITY TYPE	PARALLEL LINES	PERPENDICULAR CROSSINGS
Water	24" horizontal separation	12" above water pipe
Gravity Sewer	24" horizontal separation	12" above sewer pipe
Force Main Sewer	24" horizontal separation	12" above force main
Natural Gas	60" horizontal separation	12" below gas pipe
Steam or Hot Water	24" horizontal separation if insulated, 48" if not	12" vertical separation if insulated, 24" if not
Open Communications	12" horizontal separation of tamped soil or 3" of concrete	12" vertical separation of tamped soil or 3" of concrete
Secure Communications	24" horizontal separation of tamped soil or 6" of concrete	24" vertical separation of tamped soil or 6" of concrete
Electrical (not under same "ownership")	12" horizontal separation of tamped soil or 3" of concrete	12" vertical separation of tamped soil or 3" of concrete

The Drawings should contain detail(s) reflecting the requirements in LANL design standard drawings ST-G30GEN-4 and ST-G30GEN-5.

3.2 EXCAVATION AND BACKFILL

- A. Make excavation for manholes and underground ductbanks to depth required and to provide solid bearing.
 1. Set excavation so top of power ductbank concrete encasement will be not less than 24 inches below finished grade or paving.
 2. Set excavation so top of telephone ductbank concrete encasement will be not less than 24 inches below finished grade or paving.

Delete the following specification article if ductbank systems are not for secure communications.

3. Set excavation so top of secure communications ductbank concrete encasement will not be less than 36 inches below finished grade or paving (the secure duct is to be not less than 1 meter deep).
- B. Grade trenches for underground ductbanks to a minimum of 4 inches per 100 ft. toward manholes.
- C. Keep excavation dry during installation of work.
- D. Make trenches of sufficient width to receive work to be installed and provide specified concrete coverage on sides.
- E. Backfill in 6 inch layers; use soil excavated; remove roots, rocks and sharp objects. Provide coarse sand as required for additional backfill material.
- F. Moisture condition backfill soil and compact in accordance with ASTM D 1557 to 95% maximum density under paved areas and 90% maximum density under unpaved areas.
- G. Overfill trenches to allow for settlement.
- H. Refer to Section 02310 - *Grading, Excavation and Trenching* for additional requirements.

3.3 UNDERGROUND DUCTBANK INSTALLATION

- A. Install the number and size of ducts as indicated on the Drawings.
- B. Use the following duct materials:

Edit 1 through 4 to match Project requirements.

1. Use Schedule 40 rigid non-metallic conduit, Type EB utility duct, galvanized intermediate metal conduit, or rigid galvanized steel conduit for low voltage lighting, power or control wiring.
 2. Use Schedule 40 rigid non-metallic conduit, Type EB utility duct, galvanized intermediate metal conduit, or rigid galvanized steel conduit for communications ducts.
 3. Use Schedule 40 rigid non-metallic conduit, Type EB utility duct, galvanized intermediate metal conduit, or rigid galvanized steel conduit for utility level medium voltage power ducts.
 4. Use plastic-coated galvanized rigid steel conduit, tape-wrapped galvanized intermediate metal conduit, or tape-wrapped rigid galvanized steel conduit for elbow and riser where ducts turn up to the surface.
- C. Grade ducts to drain to manholes; do not trap ducts.

- D. Use the smooth earth walls of trenches as forms for concrete encasement of ducts.
- E. Make changes in direction of duct runs using long sweep bends with a minimum radius of 25 feet. Where ducts turn up into the surface, use RGS, IMC or PVC coated rigid steel elbows with minimum 36 in. radius; terminate in a coupling 4 in. above the surface or equipment pad. Install zinc-plated malleable iron pipe plug in each unused duct stub-up.
- F. Support ducts with duct spacers placed at intervals not exceeding 5 ft.
- G. Anchor ducts to bottom of trench using reinforcing steel and wire at intervals not exceeding 10 ft.
- H. Terminate power and telephone ducts in manholes, vaults and building walls using bell end fittings.
 - 1. For ducts installed through holes cut by the contractor in existing building, vault or manhole walls, pack opening with non-shrink grout. Feather the edge of the grout around each bell and conform to the curvature of the bell end. Remove sharp edges and projections and fill voids within 6 inches of bell ends.
 - 2. For concrete-encased ducts installed in new manholes through a knockout panel, after removing forms from the end of the ductbank, rub the exposed concrete surface smooth. Feather the edge of the concrete around each bell and conform to the curvature of the bell end. Remove sharp edges and projections and fill voids within 6 inches of bell ends.

Delete the following specification article if ductbank systems are not for secure communications.

- I. Terminate secure communications ducts on secure junction box in manholes, vaults and building walls using threaded rigid galvanized steel conduit or IMC that extends at least 4 ft into the ductbank structure.
 - 1. For secure ducts installed through holes cut by the contractor in existing building, vault or manhole walls, pack opening with non-shrink grout.
 - 2. For concrete-encased secure ducts installed in new manholes through a knockout panel, extend secure ducts through the form to the secure junction-box, and after removing forms from the end of the ductbank, rub the exposed concrete surface smooth.
- J. Ground metallic conduit exposed to contact according to the requirements of NFPA 70. Use exothermic welded connections for concealed grounding connections.
- K. Install a 4/0 AWG bare copper ground cable centered within each ductbank; connect to ground cable in manholes using exothermic welds or IEEE 837 certified compression connectors.
- L. Make-up joints in underground ducts to be tight, driven home on both sides and thoroughly waterproof. On non-metallic ducts use manufacturer's recommended solvent-cement. On metallic conduits, coat male threads with red colored, alkyd base, tank and structural primer that is suitable for galvanized steel; make up fittings wrench-tight.

Delete the following specification article if ductbank systems are not for secure communications.

- M. Mark secure communication ducts with red paint on 5 foot centers.
- N. Where metallic conduits exit concrete encasement, use plastic coated rigid steel conduit or tape wrap with corrosion protection tape, half-lapped. Wrap IMC or RGS conduit 12 inches on each side of exit point and wrap all metal conduits in contact with earth.
- O. Encase ducts in concrete to provide not less than 3 inches of coverage on all sides.
 - 1. Use red concrete for ductbanks containing medium voltage cables.
 - 2. Place concrete using deflecting trough directing concrete through the duct assembly.
 - 3. Place concrete envelope as one monolithic pour where possible; taper any joints with a 10:1 slope.
 - 4. Allow for expansion/contraction of ducts; place concrete starting at one end of ductbank allowing the free end to move.

Delete the following specification article if ductbank systems are not for secure communications.

- 5. The LANL Chief Information Office-PTS group must perform an inspection of the secure ductbank system prior to encasing with concrete.
- P. Test each duct for blockage or deformation after concrete has cured for 24 hours.
 - 1. Use a flexible mandrel/scrapper not less than 12 in. long with a diameter approximately 1/4 in. less than the inside diameter of the duct.
 - 2. Pull a mandrel behind a brush with stiff bristles.
 - 3. Replace any duct section found blocked.
 - 4. Notify LANL Contract Administrator 10 days before duct tests; submit written reports of tests to LANL Contract Administrator.
- Q. After ducts have been successfully tested, backfill the trench. Place underground warning tape in backfill 12 inches below the surface.
- R. Install measuring and pulling tape in each duct. Leave not less than 12 inches of slack at each end of the tape. Secure each end of tape.
- S. Stub-Up Connections:
 - 1. Use rigid steel conduit or IMC for outdoor stub-up connections. Non-metallic conduit may be used for indoor stub-up connections that are not subject to physical damage.

2. Extend conduits through concrete pad or floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor or equipment pad.
3. Where equipment connections are not made under this Contract, install threaded insert plugs set flush with the floor.

T. Install corrosion protection tape on metal conduits and fittings in contact with soil using half-lapped wrappings.

Delete the following specification article if manholes are not needed.

3.4 MANHOLE INSTALLATION

- A. Install manholes at locations indicated on the Drawings.
- B. Make excavation of suitable dimensions so ducts enter manhole at proper elevation and so waterproofing can be applied on exterior of in-place manhole. Refer to Section 02310 - Grading, Excavation and Trenching, for additional requirements.
- C. Install at least 6 in. sand bedding under manholes; compact to 95% maximum density accordance with ASTM D 1557.
- D. Install a 2 ft. X 2 ft. X 2 ft. sump of 3/4 in. gravel below the drain sump opening in the bottom ring of the manhole.
- E. Place premolded joint filler in joints between bottom ring, top ring, grade rings and manhole frame. Install following manufacturer's instructions.
- F. Apply liquid asphalt emulsion damp proofing material to exterior surfaces of manholes by brushing or spraying at a rate of 1.5 to 2.5 gallons per 100 sq. ft., depending on substrate texture, to produce a dry film thickness of not less than 15 mils. Apply multiple coats if necessary to obtain required thickness; allow drying time between coats.
- G. Install a continuous loop of 4/0 AWG bare copper ground cable around inside walls of manholes at floor level.
 1. Attach to walls using copper or cast bronze cable holders and masonry anchors.
 2. Connect to duct bank ground cable using exothermic welds or approved non-reversible compression fittings.
 3. Ground metallic conduits or duct bell ends to ground cable loop using exothermic welds or approved non-reversible compression fittings.
 4. Ground metal cable racks and permanent ladders using exothermic welds or approved non-reversible compression fittings.
- H. Install cable racks as required to support cables at intervals not exceeding 3 ft. Coordinate quantity and types of racks and arms with the LANL Support Services Subcontractor electrical distribution engineer and the LANL Telecommunications Group.

- I. For manholes in unpaved areas install an 8 ft by 8 ft by 6 inch concrete apron around manhole frame and cover. Taper the concrete one inch away from the frame to the edge of the apron for drainage.
- J. Stamp manhole structure number on north edge of manhole ring. Use steel dies with 3/8 inch or larger characters.

3.5 DUCT PLUGGING AND SEALING

- A. Install duct plugs in both ends of all unused ducts that cross any natural gas line.
- B. Install duct sealant in both ends of all ducts containing cables that cross any natural gas line.

END OF SECTION

Do not delete the following reference information:

FOR LANL USE ONLY

This project specification is based on LANL Construction Specification 02580, Rev. 0, dated March 29, 2004.